Impact of climate change on smallholders and their coping strategies

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MSC
MicroSave Consulting

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List of acronyms

Acronym	Expanded form
KCC	Kisan credit card (Agriculture working capital loans)
KVK	Krishi Vigyan Kendra (Agriculture science advisory centers)
SHF	Smallholder farmer
SHG	Self help Group

Introduction to the study

Background and objectives of the study (SCQA)

S — We know that…

…climate change will exacerbate the impact of hydrometeorological events and floods will be the most devastating of climate hazards in the future. The world will probably experience more than 1,500* floods between 2023 and 2030.

This implies that the agriculture economy and the smallholder farmers (SHFs) will be severely affected unless they develop mechanisms to mitigate the increasing risk of flooding and land degradation.

C — However, we have little understanding of…

…what are the direct and indirect impacts of climate change on SHFs, and their adaptation strategies for the impact of climate change.

We don’t understand the role of human capital, social capital, physical capital, natural capital, and particularly the financial capital, in strengthening the climate resilience of smallholder farmers. The role of system-level actors in the SHFs climate resilience strategy is also unclear.

Q — Therefore, what are those…

…set of metrics that can determine the smallholder farmers' resilience against climate change before, during, and after the interventions aimed at strengthening their climate resilience?

Can the implementation model be made cost-effective encouraging programs and policymakers to use them extensively?

Will it lead to an increasingly better understanding of the effectiveness of interventions?

A — We undertook primary research…

…to understand the direct and indirect impacts of climate change on SHFs in Bihar and their resilience strategies.

We interacted with 54 SHFs and 12 system-level actors to understand their role in strengthening the climate resilience of SHFs.

Based on our findings we formulated a set of quantitative metrics that can determine whether an SHF is resilient against the impacts of climate change or not.

Research questions

1. What are the direct and indirect impacts of climate change on smallholder farmers in Bihar?

2. What strategies (ex-ante and ex-post) do the smallholder farmers adopt to minimize the effect of such events and recover quickly from losses and damages caused by these events?

3. What are the roles of formal or informal financial services in informing the resilience strategies of smallholder farmers? What barriers exist to using those services and deriving value from them? Are there distinct barriers for women to access these strategies?

4. What are the roles of eco-system actors such as input suppliers, output buyers, financial service providers, insurance providers, agriculture extension agents, farmer producer organizations, sponsoring agencies such as *JEEViKA*, and government agencies (policies, subsidies, and services) to form a part of the resilience strategies of smallholder farmers?

5. What are those key metrics for identifying and quantifying the climate resilience of smallholder farmers?

Summary of findings

Summary of findings

RQ1: What are the **direct and indirect impacts** of pluvial and fluvial flooding, high heat, and high humidity on smallholder farmers in Bihar?

Short answer:

Direct impact: loss of standing crops due to pluvial flooding mainly during the Kharif season and subsequent decline in productivity due to loss of top soil. The increased heat and humidity has also increased pest infestation. However, fluvial flooding (less frequent) has a positive ex-post effect on soil fertility.

Indirect impact: Declining productivity leading to higher use of fertilizers, reduction in the nutrient content of food and fodder, deterioration in the quality of milk, diminishing marginal return from agriculture, and a tendency of migration among younger generations.

More details: **CTRL+ Click to go to the slides**

RQ2: What **strategies (ex-ante and ex-post) do the smallholder farmers** adopt to minimize the effect of flooding and recover quickly from losses and damages caused by these events?

Short answer:

Ex-ante strategies: arrange dry food and fodder for livestock, arrange emergency funds in cash, arrange essential medicine, relocate to pucca houses of relatives and neighbors, and keep food and essentials on rooftops.

Ex-post strategies: cultivate short-duration vegetable crops to make up for crops lost to flooding, increase the use of fertilizer to increase vegetable yield, take up jobs in cities to make up for losses, and borrow from MFIs and money lenders.

More details: **CTRL+ Click to go to the slides**

Summary of findings

RQ3: What are the roles of **formal and informal financial services** in strengthening the financial resilience of smallholder farmers? What are the barriers to accessing these services? What are the gaps in these products and services that lower their relevance as an instrument to cope with climate shocks?

Short answer:

Role of financial services: Loans from local money lenders, and loans from SHGs help smallholders to recover and reconstruct after major events such as a flood. However, loans from MFIs are not that useful in these situations.

Barriers to accessing these services: Poorly designed products, lengthy and obscure documentation processes, and bribery are some of the barriers to why poor smallholder farmers are unable to access these services. Women have a better chance of availing of credit because MFIs and SHGs lend exclusively to women. However, it is not easy for women to borrow from money lenders due to existing social norms.

More details: **CTRL+ Click to go to the slides**

RQ4: What are the roles of **system-level actors** such as agriculture value chain aggregators, input suppliers, veterinarians, agriculture advisors, CICO agents, and MFIs in strengthening the climate resilience of the SHFs?

Short answer:

Positive role: The veterinarians, input suppliers, and agriculture advisors help smallholder farmers by advising. Value chain aggregators make timely payments against purchased commodities to ease the liquidity situation of the affected farmers.

Neutral role: CICO and MFIs do not help much as their business model does not allow the facilitation of beneficial services to the affected people.

More details: **CTRL+ Click to go to the slides**

Summary of findings

RQ5: What are those **key metrics** for identifying and quantifying the climate resilience of smallholder farmers?

Short answer:

The ability to invest in non-farming assets, the availability of timely and affordable credit, the availability of suitable and trustworthy insurance products, the quality of available farmland, the ability to diversify livelihood, the availability of timely and credible weather information, and crop advisory, and association with supporting institutions and cooperatives are the key factors that determine the climate resilience of smallholder farmers in Bihar.

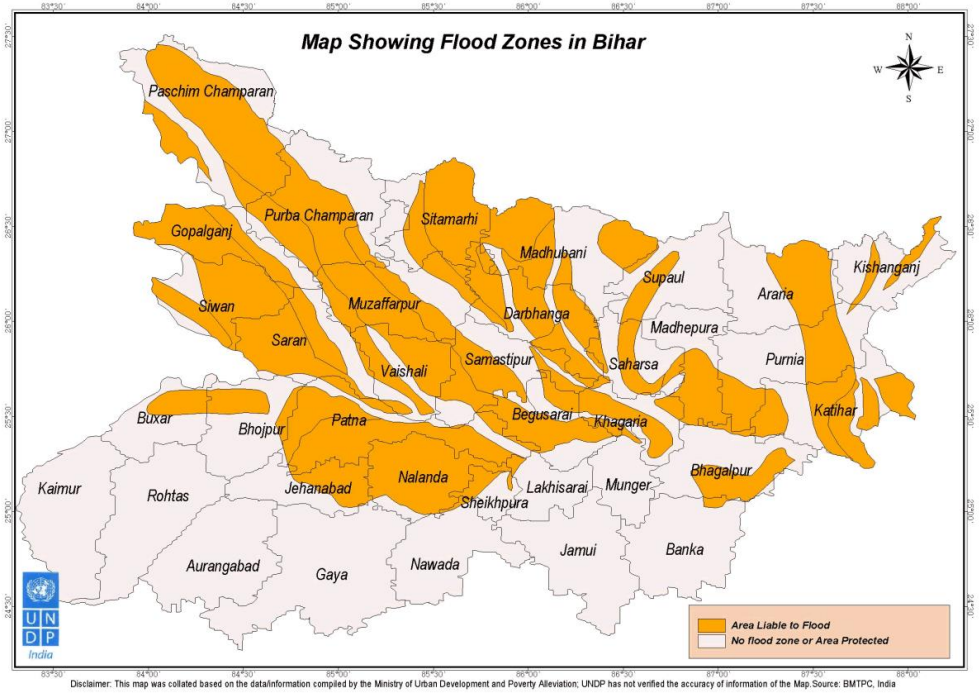
More details: **CTRL+ Click to go to the slides**

The direct and indirect impact of climate change on smallholder farmers

Flooding is the most significant climate hazard in Bihar…

Bihar is one of India's most flood-prone states. An estimated 45.24% of the State's area is flood-prone. North Bihar is more prone to flooding due to rainwater runoff from Nepal and fluvial flooding of the rivers Gandak and Kosi. The increasing heat and humidity are intensifying localized rainfall and risks of pluvial flooding.

- Smallholder farmers unanimously stated that flooding is the major weather hazard in their villages. However, Class-III floods, caused due to congestion in the river confluence are the most damaging type of flood. Class - III flood lasts the entire monsoon season, results in water logging in low-lying farmlands, damages crops, and while receding, drains away the fertile topsoil.
- The respondents in Muzaffarpur recalled the devastating 1987 floods and more recent Class III floods in 2020-21.
- In Khagaria respondents recalled floods in 2002, 2004, 2007, and again in 2021 due to heavy rainfall in the region.
- The smallholder farmers (SHFs) also mentioned increasing humidity and a rise in cyclonic rainfall.
- The respondents in both districts mentioned heatwaves in the last two years had also had a damaging effect on crops.



"Dry spell is followed by a heavy rain (cyclonic rainfall), the weather is becoming like that of Odisha and West Bengal (hot and humid)."

- Sunaina Saran, village - Sarmaspur, Muzaffarpur, Bihar.

…and its disruptive effect on livelihood is increasing

The respondents identified that the disruptive effect of flooding on their livelihood has increased recently.

Figure 11.1: In recent years flooding is the most disruptive climate event that our respondents experienced

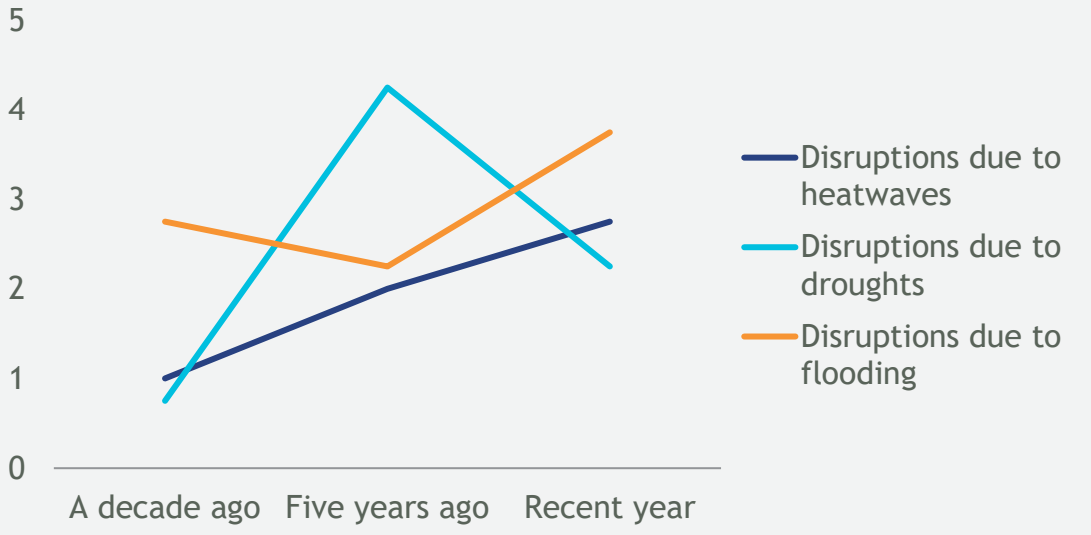
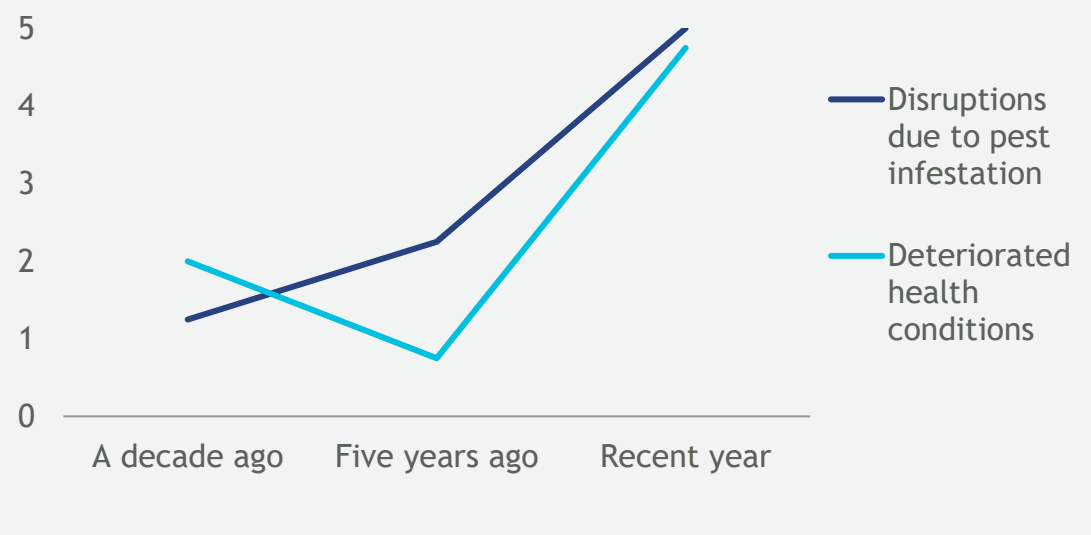


Figure 11.2: As a result of flooding and increased heat and humidity pest infestation has increased. The recent disruptions in the health situation is attributed to the impacts of Covid-19.



MSC used its time-series crisis tools to understand the trend of disruptive crises in the lives of the respondents.

An analysis of the trend of crises in the lives of the respondents revealed that the livelihood impact of flooding and extreme heat is increasing. In addition to these, pest infestations, diseases among livestock, and the Covid-19 pandemic are the most disruptive events that can be linked to the ecological imbalance caused due to climate change.

The direct impact of flooding and increased heat and humidity are…

Flooding

- **Damage to Kharif crops:** Flooding damages standing crops by inundating fields. However, flood damage to crops is restricted to the Kharif season (June to October).
- **Erosion of topsoil:** Pluvial floods carry topsoil away while retreating resulting in loss of fertility and increased salinity.
- **Damage to infrastructure:** Major floods such as the one in 1987 and 2007 have caused major damage to houses, especially mud houses, roads, electricity transmission structures, etc. However, the more frequent and regular, pluvial floods make access to services a major challenge.
- **Increased incidences of water-borne diseases:** Flooding contaminates sources of drinking water and causes increased incidences of water-borne diseases.
- **Impact on mental health:** increased emotional stress due to incidences of illness, injury, loss of physical and financial assets, and the uncertainty of recovering, among others.

Heat & humidity

- **Loss of crop productivity:** Productivity of crops has declined due to increased stress of heat and humidity. Rabi crops such as wheat and beans are particularly vulnerable to the rise in temperature and humidity.
- **Loss of livestock productivity:** Similarly, the recent increase in heat and humidity has resulted in a decline in milk production among cattle and buffalos.
- **Pest and pathogenic infestation:** A combination of high heat and humidity increases the incidences of insects, fungi, bacteria, and viruses that affect crops and livestock equally. There are reports of increased incidences of diseases among cattle such as foot and mouth disease, mastitis, enteritis, hemorrhagic septicemia (HS), and high fever. Some farmers have attributed the recent surge in lumpy virus infections to changed weather conditions, particularly the rise in humidity along with heat.

The indirect impact of flooding are…

Flooding

- **Depletion in the nutrient value of food:** To compensate for the losses to major crops such as rice, farmers often grow short-duration hybrid vegetable crops that require a high dosage of fertilizers, growth hormones, and pesticides. These practices are leading to the depletion of nutrients in these vegetable crops. Moreover, residues of these chemicals also result in the depletion of the nutrient quality of fodder, which in turn depletes the nutrient content of milk.
- **Increase in indebtedness:** Economic losses due to regular incidences of flooding in the Kharif season are driving smallholder farmers to borrow from MFIs and SHGs to ensure livelihood.

> The number of people engaged in agriculture has fallen over the years. Migration to cities has become common; for most families, at least one family member is living outside of the village and sending money home. With current vegetable prices being as low as INR 2 per kg, farming is no longer profitable and having alternate sources of family income is very important.
>
> **- Focus group in Itha Rasulnagar village, Muzaffarpur**

Ranking of the impact of flooding

The respondents recalled the recent pluvial flooding of 2020 and 2021 that kept villages inundated for up to 3 months. A ranking of the impact of these floods revealed that crops, livestock, food, water, and sanitation facilities were the most affected due to stagnant water.

Most affected

- **Income:** Income sources such as crops were damaged and due to prolonged inundation, the productivity of the ensuing crop declined. This resulted in a decrease in income levels.
- **Health:** Contamination of drinking water led to a surge in water-borne infections.
- **Damage to productive assets:** Productive assets such as cattle, tractors, cultivators, and even grain silos were swamped by flood waters. The stagnant water caused major damage to vehicles and grain silos.
- **Food and water:** Drinking water was scarce since the water sources were contaminated. Villagers survived mostly on dry foods such as parched/ puffed rice, gram flour, etc.

Moderately affected

- **Education:** Schools were closed during the severe flooding period of 15 days to up to a month in certain villages. However, schools hosted virtual classes, a trend set by the Covid-19 pandemic.
- **Savings:** Months-long flooding, depleted the savings of smallholders who were coping with the loss of wages due to Covid-19 lockdowns.
- **Infrastructure:** Power transmission was temporarily affected. Roads inside the villages were damaged.
- **Shops and businesses:** Shops were closed for weeks and local shops were unable to source supplies for up to a month.

Least affected

- **Security:** Theft and robbery incidences were few during the recent flooding because most houses are pucca (brick or concrete) now.
- **The burden of unpaid work:** Women in the household were engaged in caregiving activities and men had to put in additional labor to ensure basic household provisions like food, medicine, and fuel. Additionally, women reported having spent more time cooking using soggy firewood.

The impact of climate hazards on women is multidimensional and disproportionate

The physical impact of a climate hazard is the same for both genders. However, uneven exposure to the hazard and existing socio-economic inequalities result in a disproportionate level of climate vulnerabilities among men and women.

Impact on women

Unpaid Household work

- Increased cooking time due to soggy wood and biomass (fuel) and the need to boil (purify) drinking water
- Increased level of caregiving activities due to increased incidences of water-borne diseases and disrupted sanitation facilities
- Increased effort in preparing and feeding dry fodder to livestock

Worsened personal health

- Disruption of sanitation facilities affects women disproportionately exposing them to infections
- Increased physical labor coupled with an increased risk of respiratory tract infections due to exposure to firewood smoke and other waterborne infections result in worsening of the long-term health of women

Emotional stress

- Increased emotional burden of debt due to distressed borrowing from MFIs and SHGs. Respondents replied that MFIs are not-empathetic toward the borrowers and will collect their money, whatever it takes.

Impact on men

Increased physical and mental stress

- Increased level of physical and mental labor for supplying groceries, medicine, fodder, etc. to the household.
- Increased level of mental stress due to incidences of diseases, loss of assets, and uncertainty of recovery.

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Ex-ante and ex-post coping mechanisms of SHFs against the impacts of climate events

The ex-ante and ex-post response to climate hazards…

The ex-ante measures of SHFs to climate hazards such as flooding is to ensure the availability of essentials. Respondents did not mention measures that are aimed at reducing and/ or transferring the risks of flooding.

> We hear about heavy rainfall two or three days prior. We prepare a kit with ration, tarp, torches, candles, medicines, and other essentials
>
> **- Manoj Kumar, 45, Gannipur Bejha**

> We would like to have sufficient savings to deal with the damage post floods but it is unlikely. So we have to resort to moneylenders
>
> **- Nand Kumar, 61, Gannipur Bejha**

Similarly, the ex-post response is to ensure the sustenance of life by borrowing money. There are no available mechanisms or instruments to restore the livelihoods of the affected people. For example, there are no mechanisms or instruments to restore soil fertility. Therefore, farmers resort to using a higher dosage of fertilizer, damaging rather than improving the long-term soil health.

…are a mix of positive and negative coping strategies that are…

In the absence of adequate mechanisms and instruments to reduce or transfer the risks of climate hazards, SHFs are forced to resort to maladaptive coping mechanisms such as applying more chemical fertilizers to retain productivity, borrowing from money lenders to smoothen income, and migrating to cities (observed among the younger generation).

Parameters	Before	During	After
Agriculture/ Food	• Provisionary storage of dry food items like roasted gram flour, dry parched rice, and grains. • Adopt a negative coping strategy of harvesting and selling off crops at the available price.	• Use of boats to fetch food, water • Consumption of stored food and food if provided by government, NGO • Selling and consuming fish grown in flood water • Not eat to the full appetite	• Crop diversification (less dependence on water-intensive crops) • Increase in vegetable cultivation • Use of high-yielding hybrid seeds.
Livestock	• Provisionary storage of fodder for livestock • Taking livestock to a safer place	• Leaving livestock near railway lines • Taking livestock along to where the family relocates	• Consultation with veterinarians • Feeding fodder to restore health
Financial	• Arrange funds through withdrawal of savings • Loan from local money lenders	• Dependent on savings and borrowings	• Apply for government compensation and other claims • Men borrow from local money lenders, and women apply to MFIs, SHGs • Get remittances from migrant family members

…determined by the availability of knowledge and capital

Parameters	Before	During	After
Health	• Procure commonly required medicines prior to climate event	• Boiling water for drinking and cooking purposes • Open defecation or temporary covering made of grass for sanitation	• Building toilets on higher platforms • Vaccination
Migration	-	• Temporary migration / resettlement during climate event • Selling milk to buy food and other essential items	• Migration for livelihood • Alternative jobs like daily laborer
Infrastructure	• All households items are collected and kept on the roof of the house • People living in mud houses deposit their belongings with their neighbors who have houses made of brick and cement. • Buy emergency kit items such as torch/emergency lamp, solar light, candles, etc.	• Accommodation in tent-like structures near railway stations, schools, and in emergency shelters.	• Building houses on elevated platforms • Renovation and cleaning of house

The level of adoption of the identified climate adaptation strategies varies by gender…

	Not adopted	Least adopted	Regularly adopted
F	1. Parametric crop insurance 2. Livestock insurance 3. Recovery and reconstruction credit	1. Multiperil crop insurance 2. Loans from banks for income smoothening	1. Loan from MFIs 2. Loan from SHGs 3. G2P post-disaster relief
I	1. Intergroup savings 2. Intergroup credit	1. No information	1. Loan from moneylenders
L	1. Abandoning rice cultivation 2. Adopting waterlogging-resistant rice varieties	1. Cultivating millet	1. Short-duration vegetable crops 2. Heavy use of fertilizers 3. Abandoning livestock rearing 4. Building Pucca houses 5. Migrating to cities

Legend

F Formal financial

I Informal financial

L Non-financial

Women-focused
Men-focused
Gender Neutral

…and fits within the gender norms set by the society

- Women tend to play a defensive role, catering to family members, and ensuring sustenance.
- Men play the role of providers which reflects their greater (society-approved) ability to travel and interact outside the household and village.
- We did not observe any shift in the roles and responsibilities of women and men in the wake of a climate shock. Largely these lines of response are pre-defined by societal norms.

Except for reaching out to different sources to borrow money, no significant changes were observed in sharing of responsibilities in the event of a flood.

Women play defensive roles as per existing gender norms

Women tend to relocate to their maternal homes or to relatives' house with children and the elderly to ensure their safety. However, it is this role of women that lenders such as MFIs trust and therefore women are preferred borrowers for them. Moreover, Livelihood development agencies such as *JEEViKa* wants women to become self reliant and entrust them with credit and technical advisory.

Men play the role of providers, a responsibility bestowed upon them by societal norms

Men help their family members relocate, and arrange food, medicines, and shelter during the flooding. They brave water-logged roads to access these necessities. They take the risk of borrowing from moneylenders.

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Role of financial services in strengthening the climate resilience of SHFs and current barriers to adoption

Role of formal and informal financial services in strengthening climate resilience of smallholder farmers

Type of financial product	Description of the products/ services	Current role in strengthening climate resilience of smallholder farmers
Loan from local money lenders	Local money lenders such as large farmers, traders, and traditional money lenders offer unsecured loans. These are provided without any documentation and these are instantly disbursed. Local money lenders can exert social and political power to ensure the timely recovery of their loans.	Loans from local money lenders play a significant role in financing reconstruction and recovery from the impacts of flooding. Additionally, these loans can be availed instantly from any money lender locally, saving affected people the hassle of commuting to avail of the loans. Finally, these loans are disbursed in cash. This helps the affected people to pay for necessities without having to access cash from banks, ATMs, or BC points that become inaccessible during the floods.
Loan from MFIs	Microfinance institutions have become ubiquitous in villages. They offer unsecured loans to women who have a valid KYC document and are not a past defaulter. The loan amounts have increased significantly in recent years.	The loans from MFIs play a role in income smoothening. However, they are not particularly helpful during distress situations. Rather these loans become a burden to calamity-affected households. This is because MFIs don't offer moratorium unless the impact of the flood is severe and their collection officers are unable to access the villages.
Loans from SHGs	Members of SHGs affiliated with the *JEEViKA* program can avail of loans from their SHGs. These loans are unsecured and cheap.	Loans from the SHGs help with income smoothening and also post-disaster recovery and reconstruction. Moreover, members have the flexibility to default and not get penalized for it. *JEEViKA* due to its deep capital ensures timely repayment to banks even if end borrowers default.

> "Earlier we used to take loans from the *Mahajans* (informal moneylenders). Now, women are part of JEEViKA…Anyone can get money by asking within the group."
> - Ava Kumari, 33, Itaha Rasulnagar, Bihar

Barriers to accessing the available financial services that may have a role in strengthening climate resilience

Type of financial product	Description of the products/ services	Possible role in climate resilience, barriers to access them, and gaps in current products that lessen their relevance as an instrument of coping with climate shocks
Kisan Credit Card	Kisan credit cards (KCCs) are working capital loans available to farmers who own agricultural lands. They are unsecured and are available for short (up to two cropping seasons/ biannual) and long duration (more than a year)	KCCs can play important role in strengthening the climate resilience of smallholder farmers because these loans are for meeting working capital expenses. However, the key barrier to accessing KCC is the requirement for agricultural land. KCC is not available to landless cultivators and sharecroppers. Moreover, most banks are reluctant to provide KCC in Bihar due to the high historical default rate under the scheme. The major gaps with the product are the complex assessment process and an archaic method of computing the quantum and finance.
Multiperil crop insurance	Multiperil crop insurance is aimed at protecting the income of farmers from multiple perils that lead to crop damage	Bihar is not a member of the *Pradhan Mantri Fasal Bima Yojana*. The state has its own risk pool that allows farmers to insure their crops. It is a multiperil crop insurance scheme. The key barriers to accessing this scheme are: Smallholder farmers noted that they do not like the claim assessment process which is based on loss assessment over a wide area (a *Gram Panchayat*). They want insurance that can assess individual farm parcels and process claims. The second barrier is the involvement of bribery in the claim settlement process. Our respondents informed us that officials at the *Gram Panchayat* ask for up to 20% of the claim amount to accept a claim application.

> “I signed up for the free crop insurance given by the government, but no one receives any claims even after flood damage.” - Harish Kumar, 45, Itaha Rasulnagar

SHFs need suitable credit and insurance products and trustworthy delivery of these services

Credit		Insurance
SHFs need credit for **consumption and to invest in the revival of their livelihoods / income sources.**	Purpose	SHFs need insurance as a **risk mitigation measure of last resort.** It protects them from economic loss due to extreme weather events.
At present, they borrow from local moneylenders because they offer the **money faster, without collateral, and without any documentation.**	Success criterion	SHFs need localized assessment of losses. They need **assurance of claim settlement and faster processing of claims - without unauthorized deductions.**
Formal financial institutions do not lend money for consumption. Moreover, formal credit is either **slow or expensive** (mobile app-based digital loans could play an import role here).	Current barriers to adoption	At present, SHFs question the **basis of the assessment of loss based on crop-cutting experiments** conducted for the entire *panchayat* (comprising ~6 villages). They also alleged that local elected representatives **demand bribes** to approve their claim documents.
MFIs in India can use lessons from **Vision Funds' recovery loan program in the Philippines** after the devastating typhoon Haiyan to develop such products.	Exemplary products	The replanting guarantee scheme launched by One Acre Fund in Kenya **is a parametric insurance product that comes bundled with maize seeds.**

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Role of system-level actors in strengthening climate resilience

Role of various system-level actors in strengthening climate resilience of SHFs

Input suppliers

- Financially sound agriculture input dealers also provide inputs on credit.
- They are concerned by the excessive use of chemical fertilizers by farmers and they advise farmers to use fertilizers judiciously and suggest better-yielding seeds.
- Extreme weather events affect the demand for inputs. In the event of a flood, they have to protect their inventory and therefore incur additional expenditure, exacerbating their losses.

Technical advisory

- Veterinarians feel that ambulance services will improve the delivery of livestock health services.
- They want farmers to improve the quality of feed. However, they understand that the low marginal return from cattle stifles the ability of SHFs to maintain their livestock's health.
- Agriculture scientists play a vital role in the climate resilience of SHFs as they provide critical advisory services through KVKs.

Output buyers

- Output buyers sometimes offer advances to farmers for procurement of inputs. Therefore, they are members of the local money lending system.
- Sometimes they offer advisory because most of these output buyers are farmers themselves.
- Output buyers, who are pure traders are less empathetic toward farmers.

Financial services

- The MFIs are the least empathetic towards the SHFs needs. SHFs do not trust insurance products as they have to pay bribes up to 20% of the claim amount. Recently, an increase in the number of CICO agents in the villages has improved the experiences of cashing-out remittances or government benefits. The SRLM is a major provider of loans through the SHG networks. This network of SHGs has contributed significantly to the enhancement of income of SHFs and access to credit.

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Framework to measure climate resilience of SHFs

We identified seven major factors that determine the level of climate resilience. They are…

1 The ability to invest in non-farming assets:

Smallholder farmers are unable to save most of their income to make investments in non-farming assets. Most of them reinvest in agriculture. However, during a major weather event, smallholders use their savings for consumption, compelling them to borrow from informal sources to invest in agriculture. Therefore, their ability to invest their savings in non-farm sectors, even if in low-return instruments like a bank deposit is one of the major indicators of resilience.

2 The availability of timely and affordable credit:

Smallholders rely on borrowing to revive their livelihoods after a major weather event. They rely on informal credit because it is accessible and timely. No other institutions lend for economic recovery, compelling smallholders to resort to informal credit. Therefore, the availability of timely and affordable credit for reconstruction and revival of livelihood is one of the key factors of climate resilience.

3 The availability of suitable and trustworthy insurance products:

Smallholder farmers understand that insurance helps to recover from the economic impact of weather events. However, they stated that making claims is a tedious process and involves bribing local officials. Moreover, farmers feel that insurance companies should assess damages at the individual farm level. However, at present insurance companies measure the productivity loss of an entire village to determine the extent of damages they should pay to each insured farmer in that village. Therefore, an effective and trustworthy insurance product could enable the uptake of insurance products that will protect farmers against major perils.

We identified seven major factors that determine the level of climate resilience. They are…

4 The quality of available farmland:

The topography of the farmland and the availability of irrigation sources determine the quality of the farmland. For example, a low-lying piece of land will remain waterlogged for a longer period resulting in the leaching of nutrients from the topsoil. This will gradually deteriorate the fertility of the topsoil. Similarly, farmlands located near river banks will experience inundation during fluvial flooding. However, they will also benefit from nutrient-enriched silts deposited by the river.

Therefore, the natural capital is the overall quality of the farmland determined by the following metrics. The natural capital determines the ability of farmers to remain resilient against weather-related shocks.

- Irrigated v/s rainfed lands
- Low-lying v/s elevated lands
- Lands adjacent to river banks v/s lands far away from river banks

5 The ability to diversify their livelihood:

We found most young people are migrating to cities to work in the non-farm sectors. We found that households whose migrant members remit money built pucca houses on elevated lands. In the farm sector, SHFs diversify their income by cultivating vegetables and cash crops. They also rear livestock.

Over the years, the SHFs have diversified their income sources to mitigate the risk of crop failure due to adverse weather events.

We identified seven major factors that determine the level of climate resilience. They are…

6 Availability of timely and credible weather information and crop advisory:

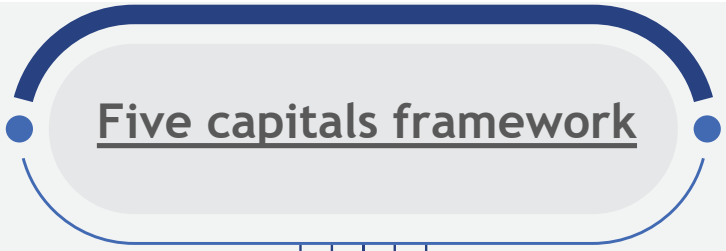
We learned that SHFs have access to weather-related information for free. The Department of Agriculture Meteorology, Government of Bihar has the necessary infrastructure in place to provide the information. In addition, to weather information, there are local agriculture advisory centers that provide credible advisory on crop production and marketing.

7 Association with supporting institutions and cooperatives:

Our study found that women SHFs that are members of the SHGs formed under the *JEEViKA* program receive a bouquet of support from the program. This includes information and advisory on farming practices, weather alerts, financial inclusion programs, livelihood diversification programs, and marketing support, among others.

The women members associated with *JEEViKA* appeared more confident of using innovative cultivation methods, improved variety of seeds, new crops, etc. Therefore, association with supporting institutions such as cooperatives, producer organizations, and NGOs strengthen SHFs capability to adapt to a changing climate.

Financial and social capital play the most significant role in strengthening climate resilience of smallholder farmers



1

Human capital

- The ability to diversify livelihood
- Education provides access to key information

2

Natural capital

- The quality and location of available farmland

3

Physical capital

- House/cattle shed on elevated land
- Pucca house/cattle shed

4

Financial capital

- The ability to invest in non-farm assets/savings deposit
- The availability of timely and affordable credit
- The availability of suitable and trustworthy insurance products

5

Social capital

- Availability of timely and credible weather information and crop advisory
- Association with support institutions, SHGs and cooperatives

Metrics for assessing climate resilience of SHFs

Based on these 12 questions, we will develop a resilience score for each SHF in our sample.

The minimum score possible is 0 and the maximum score possible is 13.

Based on the distribution of score, we can divide the SHFs into two-three segments: Resilient, Risky, and Vulnerable. We will determine the class intervals for each segment based on the output of the IVR-based survey.

A	**Human Capital**	
1	Are you or any member of your family involved in any non-farming income generatign activity like job/business/running shop?	1. YES 2. NO
2	Other than the major rabi/khariff crop, do you do other types or farming and/or keep livestocks to complement your income?	1. YES 2. NO
3	Do you receive remittance regularly or at the time of need from any friend/relative staying outside of your village?	1. YES 2. NO
B	**Natural capital**	
4	Does your farmland have drip/sprinkle/bore well for irrigation?	1. YES 2. NO
5	Is your farm land located at height so that flood/heavy rain cannot affect the land?	1. YES 2. NO
C	**Physical capital**	
6	Which kind of house do you have?	1. Pucca 2. Semi-pucca 3. Kachha
7	Is your house and/or cattleshed located in elevated land to avoid flooding?	1. YES 2. NO
D	**Financial capital**	
8	Do you have money saved that can be used at the time of emergencies like flood or crop loss or draught?	1. YES 2. NO
9	Do you have any crop insurance?	1. YES 2. NO
10	Do you have access to affordable loans in case there is an emergency and you need money?	1. YES 2. NO
E	**Social capital**	
11	Can you get access to weather related information so that you can understand about upcoming rainfall, heat, flood, draught, storm etc.?	1. YES 2. NO
12	Are you member of any savings group or cooperative or farmer producer company?	1. YES 2. NO

Annexure- I: the traits of resilient and vulnerable smallholder farmers

Personas




Personas Indicators	Resilient	Vulnerable
Access to formal financial services (Savings, formal loans, insurance, remittances, alternate MSME) **(Any 1 out of 5)**	Y	N
Utilization of climate-resilience building technology (Inputs, access to updated weather information, short-duration crop seeds, line sowing, farming on a raised platform) **(Min of 2 out of 5)**	Y	N
Nature of available physical assets (Irrigated land, concrete house, livestock, smartphones) **(Min of 2 out of 4)**	Y	N

Resilient: Anamika Kumari (case 1)

Age: 38
Marital status: Married
Education: M.A.

Landholding: 3 acres
Type of land: Irrigated
Livestock: 3 Cows

Type of house: Pucca
Smartphone access: Yes

> Apne itchaon ko seemit rakhini chahiyea (We need to control our desires)

Personality traits

- She is educated and holds a bachelor's degree. She has knowledge of new scientific farming methods
- Has taken initiative to diversify household income by providing tuition and selling milk to the cooperative
- Has knowledge and understanding of climate change and its negative impact
- Has awareness of the various financial products that are available
- She stated that she differentiates between needs and wants so that she can build savings as these are the primary source of financial resilience in a crisis

Adaptation to climate change

- Cultivates vegetables using hybrid seeds. These vegetables offset loss from damage to principal crop.
- Has a bore-well pump irrigation system installed on the farm
- Uses the required amount of fertilizers after consulting the agri-input provider
- Started cultivating millets as they require less water

Access to financial products

- Takes loans from MFI like Arohan MicroFinance @ 26% interest PA
- Has access to loans from self help groups (SHGs) @ 1-2% interest per month
- Has a bank account at Union Bank where she deposits her savings & receives remittances from son / family members
- Takes informal private loans from moneylenders @ 3-5% interest per month
- Withdraws money from banking agents (Bank Mitras)

Usage of smartphones

- Checks news and weather updates for her area
- Uses WhatsApp, Facebook, and YouTube for entertainment
- Uses PhonePe, Paytm, and Google Pay for digital payments
- Checks the details of various schemes
- Keeps herself updated on new farming techniques

Resilient: Vandana Devi (case 2)

Age: 35
Marital status: Married
Education: 10th Pass

Landholding: 1 acres
Type of land: Irrigated
Livestock: 2 Cow, 1 Buffalo

Type of house: Pucca
Smartphone access: Yes

> Mein murkh hoon magar mein chahti hoo ki mere bache pade aur age badhe (I am not well educated, but I want my children to study and go ahead in life)

Personality traits

- A key decision maker in her HH along with her spouse, she is confident and feels the need to increase her knowledge of climate resilient farming. Feels proud to contribute to her family income through farming
- Was very eager to learn about the climate-resilient farming technologies
- Was aware of the climate changes in her district
- Keen to have access to weather updates and forecast before sowing
- She wants her kids to study well and progress in life (choose non-farm livelihood / jobs).

Adaptation to climate change

- Cultivates vegetables using hybrid seeds. These vegetables offset loss due to damage to principal crops.
- Rents pump set @ INR 200 (USD 2.66) per hour for irrigation in dry periods
- Uses an increasing amount of fertilizers to increase the yield

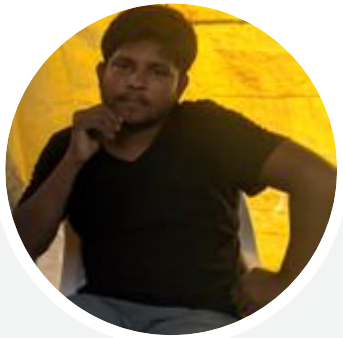
Access to financial products

- Has taken loans through Kisan Credit Card (KCC), a subsidised loan product for farmers
- Accesses loans from microfinance institutions
- Has taken loans from SHGs & *Jeevika* @ 1-2% interest/ month for farming & building a pucca house
- Saves INR 2,000-4,000 ($27-54) per month in a bank account
- Takes informal loans from moneylenders in the village @ 3% interest per month
- Has life insurance
- Husband sends remittances (INR 25,000 ((USD333) per month) to her bank account

Usage of smartphones

- Makes calls and reads messages
- Uses WhatsApp for messaging and communication
- Does not use any digital payment application

Vulnerable: Mohammad Saqlin (case 3)



Age: 25
Marital status: Single
Education: 10th Pass

Landholding: 3.5 bigha
Type of land: Unirrigated
Livestock: 1 Cow, 3 Hen

Type of house: Kutcha
Smartphone access: Yes

> Aaj kisan bas apne bharose hai (Today the farmer is on his own; there is no support)

Personality traits

- Limited awareness about new farming methods
- Family is dependent on agriculture for livelihood
- Does not see a future in agriculture and wants to migrate to urban areas
- Limited awareness of various financial products that are available
- Believes that there is no institutional support for farmers and they are on their own when there is a calamity.

Access to financial products

- Owns a bank account in State Bank of India, but has no savings
- Takes informal private loans from moneylenders @ 4-5% interest per month
- Is not aware Kisan Credit Card (KCC), its processes, eligibility, or requirements

Adaptation to climate change

- Cultivates vegetables using hybrid seeds. These vegetables offset loss due to damage to principal crops of rice and maize.
- Rents pump set @ INR 250 (USD 3.33) per hour for irrigation in dry periods
- Uses an increasing amount of fertilizers to increase the yield

Usage of smartphones

- Makes calls and reads messages
- Uses WhatsApp to communicate with friends and family members
- Does not use any digital payment application

Vellum layers on livelihood portfolios

Introduction to our respondent- Ava Kumari

Basic profile	• Name: Ava Kumari • Gender: Female • Age: 33 Years • Farmer type: marginal farmer
Major sources of household income	• The major sources of household income is the cultivation of field crops (maize and wheat) and seasonal vegetables. • Her family cultivates 1.25 acres of farmland. They own 0.25 acres of it.
Status of financial inclusion	• Her family has a savings bank account • She is a member of JEEViKA. As a self-help group (SHG) member, she has access to institutional credit. • Her family has obtained crop insurance under the Bihar State Crop Assistance Scheme
Usage of mobile phones	• She uses a smartphone. She can read and send messages via WhatsApp. She watches videos on Youtube.
Household information	• Family members: Her family consists of five members- her husband, two children (13 years and 11 years), and her mother-in-law • He husband cultivates the field. Her mother-in-law is aged (60 years) and does not contribute to the family income.

Ava Kumari's livelihood portfolio over time

Childhood
C. 2000

Maize was the staple crop and sweet potato was the main "vegetable".

First child
C. 2010

Rice, wheat, and maize continue to be the major crops. However, the cultivation of a variety of vegetables has increased due to increased access to markets and information.

Now
C. 2022

Wheat has replaced maize as a staple. The variety of vegetables has increased. They don't grow sweet potatoes anymore. They buy it for consumption.

Her household has two cattle. They sold off the four goats they reared around 2018. She wants to rear goats once again because the demand for goat milk is increasing.

Since 2010, Ava is employed with JEEViKA. She works as a health and nutrition advisor for pregnant women and postpartum mothers. She earns a stipend of INR 5,000 (~USD 60)

Ava Kumari's livelihood portfolio: Ex-ante resilience strategies

Childhood
C. 2000

No recollection of specific events.

First child
C. 2010

"Income from agriculture has become uncertain…there is no assurance of production. Prices (of inputs and outputs) also fluctuate. The school fee alone is INR 2,000 per month. Farm income is not sufficient"

Since 2010, Ava is employed with JEEViKA. She works as a health and nutrition advisor for pregnant women and postpartum mothers. She earns a stipend of INR 5,000 (~USD 60)

Now
C. 2022

Her association with JEEViKA provided her access to timely loans. She contributes INR 100 (USD 1.33) per month to the SHG-led group savings scheme.

JEEViKA is an exemplary program that has intentionally improved the livelihoods of Bihar's rural poor, particularly SHFs. JEEViKA is a major contributor to a sound ex-ante resilience strategy of SHFs in Bihar

Ava Kumari's livelihood portfolio: Ex-post resilience strategies

Childhood
C. 2000

No recollection of specific events.

First child
C. 2010

Applying more fertilizer to retain productivity levels and cultivating hybrid (high-yielding) vegetables to make up for the loss of income from agriculture is the dominant ex-post strategy. Insurance and credit do not play any role in the ex-post resilience strategy.

Now
C. 2022

In recent years a combination of heat and flooding is resulting in declined productivity. Therefore, farmers end up applying higher dose of fertilizer.

Farmers are now cultivating vegetables using hybrid seeds. Vegetables provide better return on investments.

Annexure-III: Research and sampling methodology

Research methodology and sampling (1/2)

Research methodology

The research exercise involved qualitative primary research in the state of Bihar to determine the metrics most suitable to determine and quantify the climate resilience of smallholder farmers. The research used research tools like Participatory Research Appraisal (PRA), In-Depth interviews (IDI), affinity mapping, product attribute ranking, Game Based Discussion, Focus Discussion Groups (FDG), and many others to develop insights and findings.

Research elements:

Sample size: 50

Location: Muzaffarpur and Khagaria

Respondent type: Farmers owning less than 2 hectares of land/ sharecroppers

Research methodology and sampling (2/2)

Sample distribution:

Sr. no.	Category	Muzaffarpur	Khagaria	
1	Input dealer	1	1	Ecosystem players
2	MFI branch manager	1	1	
3	Output trader	1	1	
4	CICO agent	1	1	
5	Local veterinarian	1	1	
6	Agri scientist of KVK	1	1	
7	In-depth interviews (IDIs)	8	6	Community members
8	Focus groups (men): 8-10 group members	1	1	
9	Focus groups (women): 5-6 group members	1	1	

Financial institutions and policymakers are key to building the Climate Resilience of smallholder farmers

MSC's research analyzed a host of financial institutions and policymakers functioning within the ecosystem.

They included both supply-side and demand-side stakeholders across the policy and financial institution landscape.

01

Demand-side = Small-Holder Farmers

Smallholder farmers include both men and women who own cultivable land measuring less than 2 hectares and sometimes work the field of large farmers (under sharecropping arrangements)'. They constituted the most important segment of our research. Investigating their degree of climate resilience helps in understanding the impact of climate change and related events on agriculture, and the gaps that financial institutions and policymakers can bridge to strengthen their climate resiliency.

02

Supply-side = Agriculture input dealer, MFI branch manager, Agriculture aggregator/output trader, CICO/BC agent, local veterinarian, and agricultural scientist/KVK

Supply-side ecosystem players include stakeholders who offer financial services and products (MFI branch manager and CICO/BC agent), government officials (agricultural scientist/KVK) and other specialist stakeholders (agricultural output aggregator, agriculture input provider and the local veterinarian). Investigating the degree of their efficiency and effectiveness in delivering services and products to the smallholder farmers helps in understanding the challenges that exist on the financial and non-financial supply side. This can be addressed by the financial institutions and policymakers to build the climate resiliency of the smallholder farmers.

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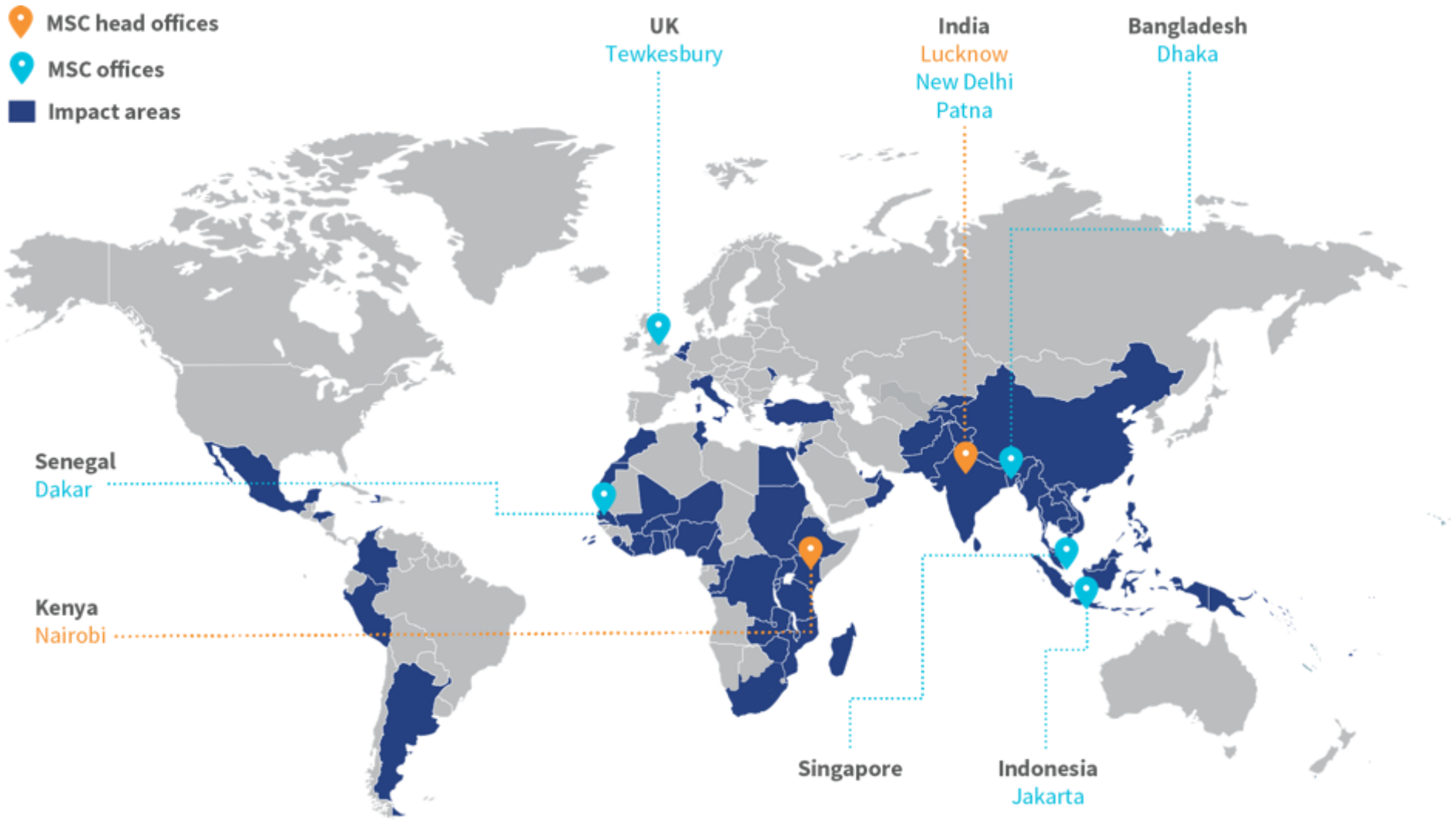

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